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SOME ASPECTS OF HIGH FREQUENCY LOUDSPEAKER DESIGN

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SOME ASPECTS OF HIGH FREQUENCY LOUDSPEAKER DESIGN

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Graphical data are presented which relate to various aspects of high frequency loudspeaker design. Response uniformity, distortion, resonance, sensitivity, impedance, and dispersion are shown as functions of such parameters as cone material and shape, cone diameter, damping pads, rear chamber volume, etc. A step by step evolution of a particular high frequency loudspeaker is described and data given.

I. INTRODUCTION

It would appear that, compared to loudspeaker design in general, very little information concerning the design of high frequency loudspeakers is available in the literature. It is the purpose of this paper to show how some aspects of design and construction effect the performance of high frequency loudspeakers. Specific examples of such loudspeakers were constructed under reasonably controlled conditions. Electrical and acoustical tests were performed for each of the examples. The results of these tests are presented and analyzed in such a manner as to manifest clearly the effect of various techniques used in the design and construction of high frequency loudspeakers.

II. DEFINING HIGH FREQUENCY LOUDSPEAKERS

The term high frequency loudspeaker is used to specifically describe an acoustic transducer which is designed to radiate useful sound output in the upper octaves of the audible spectrum. The upper frequency limit is usually only determined by practical considerations of human hearing. There are some high frequency loudspeakers which radiate acoustical energy well beyond 20kHz but for this paper, this frequency will be the upper limit of the investigations. There is, however, no clearly defined point in the frequency spectrum below which a loudspeaker should no longer be defined as a high frequency loudspeaker and instead should be called a midrange loudspeaker. Such appellations would appear to be more the result of design emphasis. For example, of the group of high frequency loudspeakers shown in Figure 1, T4 which has a rather large cup chamber on the rear, radiates useful energy well down into midrange spectrum and yet it can be called a high frequency loudspeaker because the primary design goal was to achieve smooth response to the upper limits of hearing while the secondary design goal was to find a method which would subdue the usual "honky", "nasal" quality inherent in many high frequency loudspeaker designs. It also should be noted that a loudspeaker similar to T3 has been used to reproduce the midrange frequency spectrum in a three-way loudspeaker system by at least one manufacturer.

III. FACTORS EFFECTING RESPONSE AND DISTORTION

A. Three Examples

The first three high frequency loudspeakers are designated T1, T2 and T3 and are shown in Figure 1. All three are nominally 3½" in diameter and have solid, closed back, housings. The actual, effective cone diameter is 2-3/4". Each has the same motor, consisting of a barium ferrite ring magnet and a 3/4" diameter voice coil. The voice coil is 42 turns of number 40 gauge enamel coated copper wire wound in two layers.

B. Seamed Cones vs. Felted Cones

Figure 2 shows the frequency response and the harmonic distortion of T1 and T2. T1 and T2 are identical except for their cones. T1 uses a seamed cone which is cut from sheet stock and formed on a hot press. The cone of T2 is felted to shape by a water felting process and subsequently dried. The internal dissipation of a felted cone is usually greater than a seamed cone of the same weight although there are exceptions. It can be safely said that if a group of seamed cones are made from a specific batch of sheet paper stock and another group of felted cones are made from the same paper (after it has been de-fibred for the felting process), the felted cones will have greater internal dissipation. T2, which has the felted cone, has a less ragged response and lower distortion than T1 which has a seamed cone. The high frequency response of T2, at least as indicated by Figure 2, is also more extended.